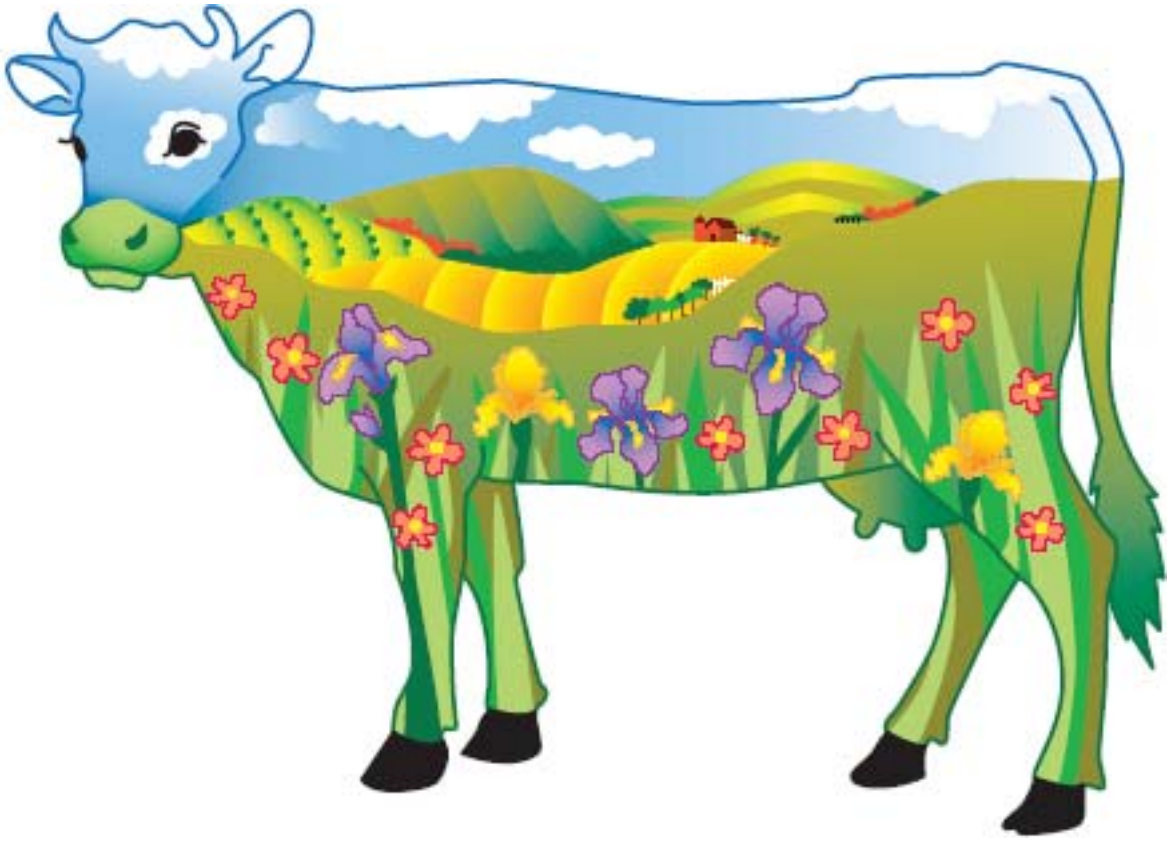
SOLE
Sciences of Life Explorations:
Through Agriculture
Grades 4 and 5



Teacher Guide
Unit: Simplified Floating Hydroponics

UNIT PLAN

UNIT TITLE

Simplified Floating Hydroponics

GOAL

This long-term project allows students to grow plants in a soilless environment

OBJECTIVES

Students will:

1. Demonstrate understanding of vocabulary related to hydroponics. (NYS Learning Standard 1: Communication Skills, Checkpoint A and B)
2. Demonstrate an understanding of how a basic hydroponics system operates and explain the various components of the system. (NYS Learning Standard 3a: Universal foundation skills, Elementary 8)
3. Demonstrate an ability to work with others and to cooperate in the coordination of periodic plant maintenance tasks. (NYS Learning Standard 4: Language for Social Interaction, Elementary 1)
4. Create a visual display of their data in the forms of graphs and charts. (NYS Learning Standard 3: Mathematics, Elementary 5)
5. Assess the transformation of a seed to a mature plant and document the speed of formation of roots, shoots, and leaves. Complete sketches and measurements on a weekly basis (NYS Learning Standard 1: Analysis, Inquiry and Design, Elementary 3)

TERMS

air pump - device that supplies air to the air stone, creating bubbles in the nutrient solution and providing oxygen to the plant roots

air stone - uses air from the air pump to create bubbles in the nutrient solution and provide oxygen to the plant roots

Germination - when the seed opens and sends up its first stem

Hydroponics - method of growing plants without soil

Nutrient solution -the plant food in a hydroponic system, which is created by mixing the proper amounts of nutrients with water.

pH - measure of whether a substance is sweet (basic) or sour (acidic)

Plant density - the number of plants in a given area (the more plants, the higher the density)

Pond - container which holds the nutrient solution, the planting tray and the air stone

Integrated Pest Management is a specialized form of environmental management wherein scientific research and real-world application work together to reduce pests such as insects, diseases or weeds.

1. Properly identify pests
2. Learn the pest/host biology
3. Sample the environment for pests
4. Determine an action threshold
5. Choose the best tactic
6. Evaluate results

SAFETY

Plastic gloves should be used when handling chemicals, and general classroom safety practices should be followed.

Standards Matrix for this Lesson

Standards:

Month	Unit	Math/Science/and Technology	English Language Arts	Social Studies	Health	Arts	Food & Fiber Literacy	CDOS	Other Languages	Interconnectedness
	Floating Hydroponics	3:9 e5	4:5 e1					3a: 2 e8		
		1:7 e3	1:6 A							
			1:6 B							

Standards Matrix Key:

NYS Learning Standards arranged by Standard: Category, Level
e = elementary i = intermediate
Categories:

1 Career Development
2 Universal Foundation Skills
3 Language for Information and Understanding
4 Language for Literary Response and Expression
5 Language for Social Interaction
6 Communication Skills
7 Analysis, Inquiry, and Design
8 Information Systems
9 Mathematics
10 Science
11 Technology
12 Interconnectedness: Common Themes
13 Interdisciplinary Problem Solving
14 History of the United States and NY
15 World History
16 Geography
17 Economics

SUPPLIES AND EQUIPMENT

A tub that will contain hydroponic solution and floating plants. This will be known as the "pond." The size depends on the size of your light source, but a plastic sweater box or dissection pan that is approximately 15" x 13" x 6.5" works well. If the pond is transparent or translucent, it should be covered with butcher paper or aluminum foil to keep light out and discourage growth of algae.

An expanded polystyrene seedling tray that is filled with growing media (soil mix)

Seeds – Romaine, butter crunch lettuce, and basil

Aquarium air pump with air stone and air tube.

Light source such as fluorescent fixture – a 4' utility light (shop light) can be purchased for about $10-25 at a hardware store and will light two hydroponic sweater-box size ponds. Alternate light sources include metal halide and high pressure sodium fixtures, or sunlight.

pH paper

Diluted Potassium Hydroxide (used to raise pH).

Diluted Hydrochloric Acid (used to lower pH). Lemon juice can be used as an alternative.

Dibble – something to compress the soil with. Can be a finger or the bottom of a test tube or something handmade as shown in the photo in the appendix.

Nutrient solution - purchase pre-mixed solution from a science supplier such as Ward's.

Aluminum foil or butcher paper to cover the pond if it is made out of a translucent material.

Tape (to attach the foil or the paper to the pond)

Stick for stirring the nutrient solution. A yardstick works well.

5- or 10-gallon bucket for mixing the nutrient solution.

Tweezers for seeding. (optional)

Petri dish for holding the seeds while seeding. (optional)

Rulers for measuring length of leaves, stems, roots etc. (optional)

Camera to record experiment photographically. (optional)

Possible Sources of Supplies:

Ward's Scientific (http://www.wardsci.com/)

- Mineral Deficiency $85 – Much easier than mixing this yourself!
- Ebb and Flood Hydroponic system: pump, timer, seed starter cubes, geolite, nutrient solution, pH test kit $180. This is a very small system and does not allow for two identical setups, but a nice demonstration tool.

Greenhouse supply companies such as Hummert (http://www.hummert.com) or Griffin (http://www.griffins.com)

- fluorescent lights
- pumps

ADDITIONAL RESOURCES

Kenyon, Stewart. *Hydroponics for the Home Gardener.* Toronto, Can.: Key Porter Books Limited, 1992.

Resh, H. M. *Hydroponic Home Food Gardens.* Calif.: Woodbridge Press. 2000

BACKGROUND FOR TEACHERS

Definition

Hydroponics refers to the practice of growing plants in nutrient solutions. This can be done either in liquid systems or in aggregate systems in which the plants are planted in a soilless media consisting of substances such as vermiculite, perlite, sand, coconut coir, expanded rock, gravel, rockwool or peat. History of Hydroponics

Hydroponics is not a new idea. The hanging gardens of Babylon were thought to be a hydroponic system. The Aztecs grew all their vegetables in a hydroponic system because the area in which they lived was a swamp and unable to support field agriculture. They scraped soil out of the swamp, placed it on top of floating wooden rafts, planted in it, and allowed the roots to grow down through the raft into the water below.

Before a more scientific approach to hydroponics could be taken, many discoveries had to be made about how and why plants grow, and how they make use of various chemicals. In 1860, Julius Von Sachs published the first recipe for a nutrient solution in which to grow plants, and he called the growing system "nutriculture." In the 1920's, Dr. William Gerizke from the University of California coined the phrase "hydroponics" from the Greek words *hydro* (water) and *ponic* (work), implying that the water does the work of providing the necessary nutrients for successful growth. In the same decade, one of the most famous recipes for the nutrient solution essential for plant growth in a hydroponic system was published by Hoagland. Called Hoagland's Solution, it is still in use today. Since the 1920's, much formal research has been performed on hydroponic systems.

Advantages of hydroponics over growing plants in soil:

- Plant density may be greatly increased per unit of growing area compared to field production, allowing more product to be grown in a smaller amount of space.
- Yield per plant is often increased. (An important point if you want to sell the crop!)
- Nutrient solution can be re-used, so less fertilizer is needed. (Good for the environment.)
- Using artificial lights, hydroponic systems may be stacked vertically, further increasing the plant yield per unit of floor space.
- Growing plants indoors allows greater control of temperature, light intensity, light quality (wavelengths of the spectrum that are used), light duration, nutrient composition and concentration, humidity, and gasses supplied to the roots.
- Plants grow faster than field grown plants.
- There is a smaller weed problem than in field grown plants.
- Plants do not need to have soil washed off, so they are ready to eat right away!

Disadvantages of hydroponics compared with plants grown in soil:

- Price – There are higher setup costs than field grown or conventionally grown greenhouse plants.
- Time – You don't have the buffer of soil to provide adequate moisture and nutrients and temperature control if the plants need to be left alone for a long time.
- Resources – plants grown in the winter must be provided with light and heat, which typically are obtained indirectly through fossil fuels.

Time Required

The initial project introduction and setup requires one 40-minute class period. Depending on the crop chosen, the project will require an average of one 20-minute data collection session every week for four or more weeks. Mini-lessons on nutrient cycling (water, carbon, nitrogen), plant growth requirements, plant responses to various stimuli (water, gravity, light) and even chemistry (pH, salt precipitation) can be used to fill the remainder of these class periods.

Potential Timeline:

Week 1

Day 1: Introduce hydroponics as a concept and give handout entitled “Introduction to Hydroponics.”

Day 2: Interest Approach Activity - Set up lights, mix nutrient solution, plant seeds.

Week 2

Day 1: (20 minutes) Measure height and make observations. Perform plant maintenance tasks.

Week 3

Day 1: (20 minutes) Measure height and make observations. Perform plant maintenance tasks.

Week 4

Day 1: (20 minutes) Measure height and make observations. Perform plant maintenance tasks.

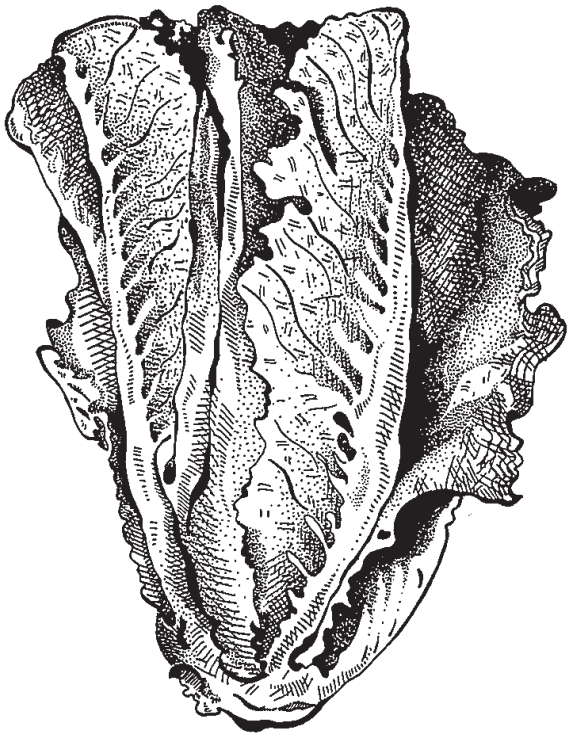
Continue for as many weeks as necessary until plants have reached their final size. Lettuce will probably be harvested by week 4.

Teaching Tips

Students probably will try to put more than one or two seeds per cell in a plug tray or per cube of rockwool. This should be highly discouraged. It’s a good idea to keep a close eye on the seeding process because students tend to become upset when extra plants must be removed after germination. If the extra plants are not removed, then they will crowd each other and not grow robustly. If many extra plants are seeded and not removed, this may provide a dramatic lesson regarding the importance of allowing plants adequate space in which to grow.

Many elementary school students do not seem to have the hand-eye coordination required to seed with tweezers. Therefore, even though it will take a long time, it might be less frustrating if they use their fingers to seed.

Students like the challenge of trying to remember all the materials they used for the experimental setup and all the steps required to plant the seeds. Therefore, it may be better to lead the class through the experimental setup and allow students to write their own materials list and procedure in a subsequent class rather than hand them a written procedure.



QUESTIONS FOR STUDENTS

Can plants grow without soil?

What does hydroponics mean?

How does a hydroponics system work?

INTEREST APPROACH ACTIVITIES

Setting up a Floating Hydroponics System

Materials:

Refer to the supplies and equipment section of this lesson

Procedure:

Note: One of the most important lessons in performing quality research is record keeping. Students should focus on keeping clear and detailed records in a notebook or set of stapled pages for every step in this experiment. Emphasis should be placed on recording visual observations of plant growth along with physical measurement of height.

1. Decide on the experimental design. Students could choose from a range of potential variables, or you could assign a variable and have them decide how to test it. Possible variables include:
   - Germination time of different plants.
   - How different pH levels affect plant growth.
   - The effect of plant density (or amount of plants per given area) changes plant yield.
   - The effect of artificial light instead of or in addition to sunlight.

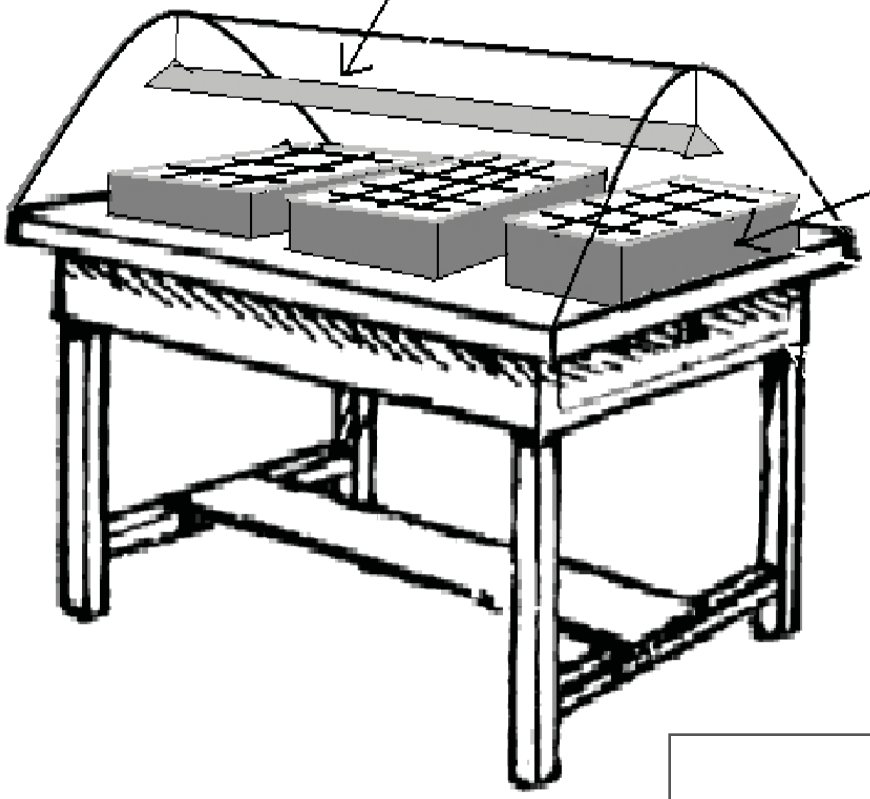
1. Assemble the hydroponic system (three systems would be ideal). Hang light fixtures and mix the nutrient solution. Cover the sides of the ponds to prevent light from entering the nutrient solution. Attach the air stones to the air tubes and then to the aquarium air pumps. Place the air stones into each pond. Draw a line with permanent maker on the inside of each pond to measure the nutrient solution levels.

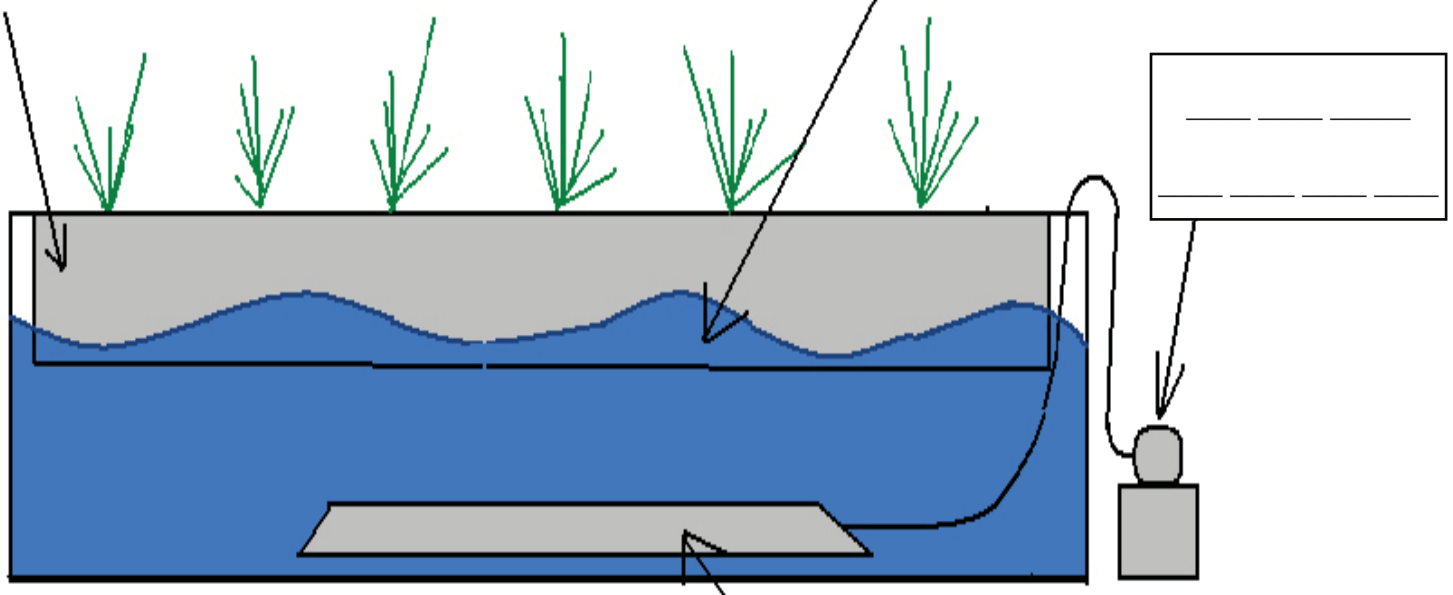
For each of the expanded polystyrene plug trays:

a. Fill with media.
b. Scrape off excess media with a flat surface so that media fills each hole.
c. Tap on the table to settle the media.
d. Press the media in each hole down to a uniform depth.
e. Place one seed per cell. (Each tray should contain <u>one</u> seed type)
f. Place more media on top of each seed, and press lightly.
g. Place into a plastic bag for germination. The length of time in the bag will depend on the germination time, which is listed on the seed packet and may vary from three days to one week.
h. When the seeds have germinated, place the entire flat into the pond filled with nutrient solution.
i. Turn on the light and air pump.

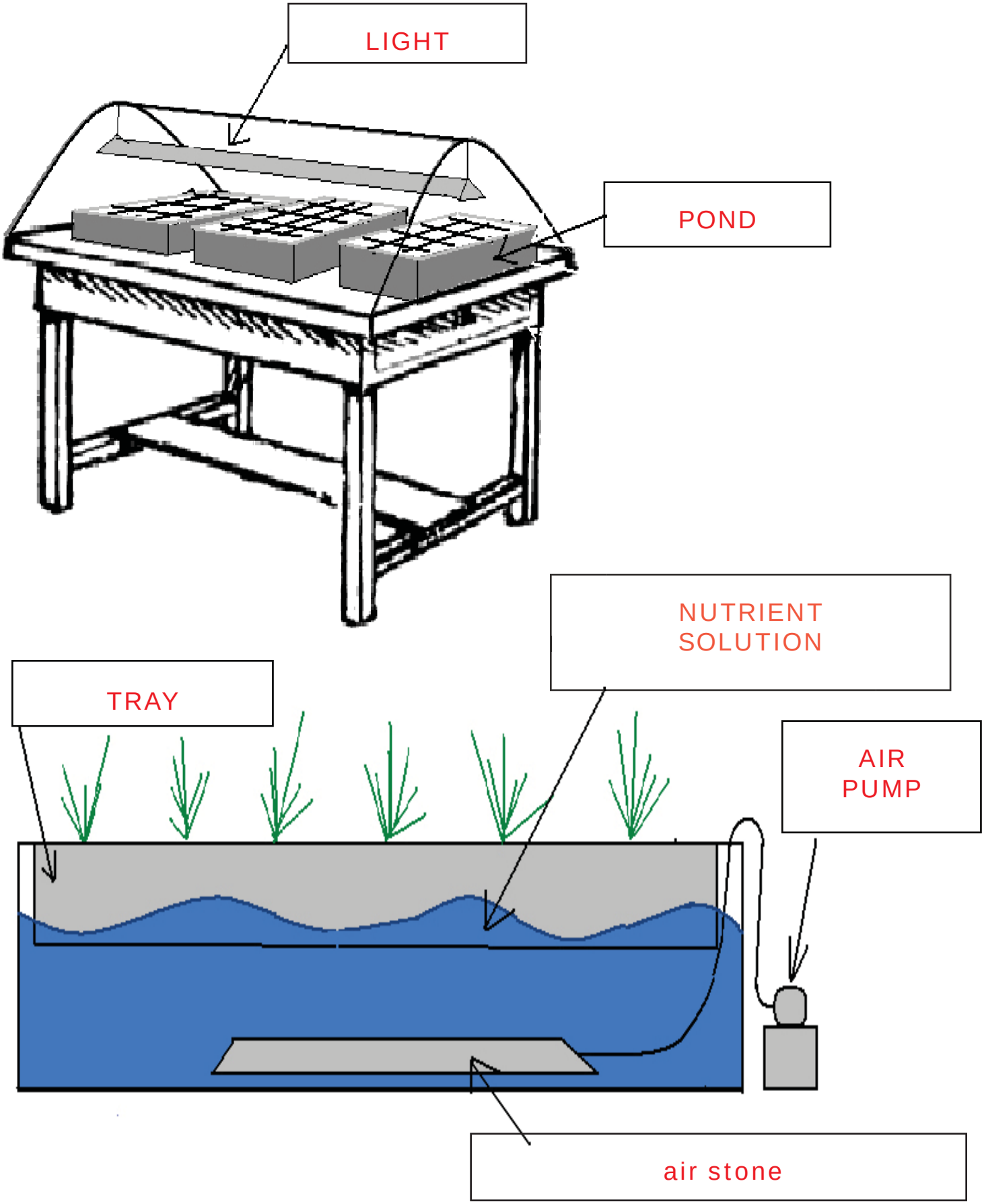
FLOATING Hydroponics name _____

Label the parts of the system





FLOATING Hydroponics
Label the parts of the system
Teacher Answer Page



SUMMARY OF CONTENT	TEACHING-LEARNING ACTIVITIES
I. Encourages students to observe hydroponics experiment	I. Make observations of hydroponics A. Measure plant heights B. Count leaves C. Note color changes D. Create graphs/charts
I. Perform maintenance tasks on the plants	II. Students take care of the experiment A. Thin plants B. Add nutrient solution C. Test pH level
III. Wrapping up A. Put supplies away	III. Wrapping up A. Turn off lighting B. Unplug air pumps C. Displose of solution down drain

name _____

Introduction to Hydroponics

What is Hydroponics?

Hydroponics from the Greek words for “water” and “working.” It is a way of growing plants without soil.

Hydroponics History

Hydroponics is as old as the Pyramids. The growing of plants in water is described in Ancient Egyptian writings dating back several thousands of years.

In the 1930’s, scientists were experimenting with growing plants without soil using nutrients dissolved in water. They found that soil is not necessary except to anchor the plant’s roots. Today this technology is widely used to grow lush, healthy indoor plants and premium grade vegetables, fruits and herbs.

How does Hydroponics work?

Plants’ requirements can be met without the use of soil or natural sunlight. Plants are rooted (and thus supported) in an inactive medium and nutrition is provided by a nutrient solution, which is plant food mixed in water.

With use of proper nutrients and the right artificial light source, today’s indoor gardener can achieve amazing results.

The plants can have an ideal environment since the gardener can control everything which is normally up to Mother Nature

Can you think of some advantages of using hydroponics**?**

_____

_____

What may be some disadvantages of using hydroponics**?**

_____

_____

Student Lessons

Student Lesson 1

Make observations on the same day each week. Possible observations include plant height, number of leaves, size of leaves, relative color of leaves if growing two different types of plants or if the experimental condition involves inducing a color change within the plant. At the end of the experiments students may create graphs or charts of their results.

Student Lesson 2

Perform maintenance tasks on the plants – the crop may need to be thinned to the spacing recommended on the seed packet, and the hydroponic solution level should be kept constant by adding either more nutrient solution or tap water. The pH of the nutrient solution may also be tested using pH paper.

Student Lesson 3

At the conclusion of the experiment, turn off the lights and unplug the air pumps. Used hydroponic solution may be disposed of down the drain.

This lesson was adapted from CSIP Graduate Fellow, Melissa Brechner's unit:

Floating Hydroponics:
Students Experiments Growing Plants without Soil